

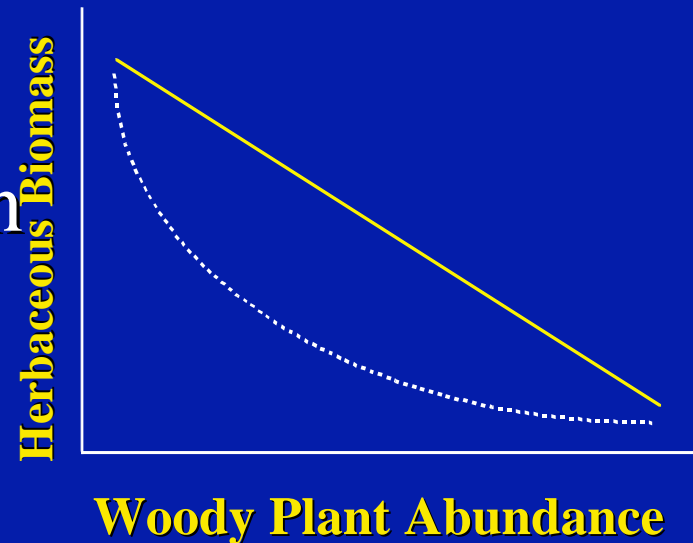
Woody Plant Proliferation in Grasslands: New Perspectives on an Old Problem

Steve Archer

**RISE Symposium
University of Arizona
13 November 2004**

Traditional Perspectives on Woody Plants in Drylands

- Livestock production
 - • forage production
 - • animal handling
 - • animal health



- Wildlife habitat management (game species)
- Watershed management
 - • stream flow
 - • ground water recharge

BIOGEOCHEMICAL PERSPECTIVE ON WOODY PLANT PROLIFERATION IN DRY LANDS

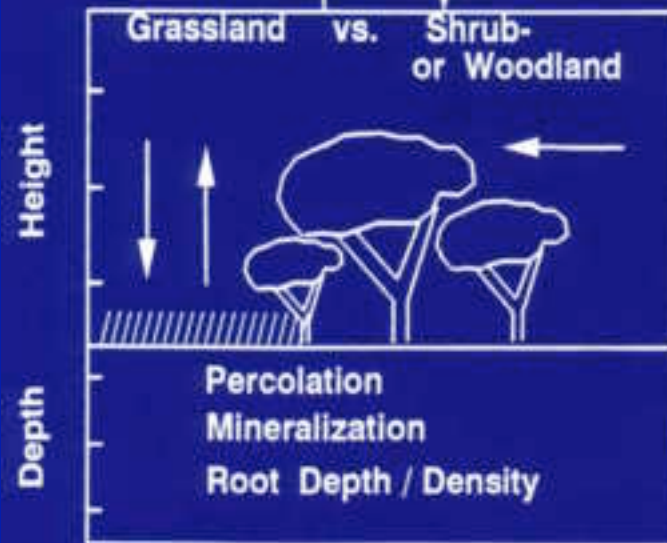
Water - Energy Budgets

Albedo
Surface Roughness
Heat Flux
Water Flux
E / T
Infiltration
Distribution

Carbon Cycle

NPP
Turnover
Stratification
Seasonality
NMHCs

MESOSCALE ATMOSPHERIC PROCESSES



BIOGEOCHEMICAL PERSPECTIVE

- Woody plant proliferation a significant component of 'missing carbon sink' in North America
 - !• Land-based based inventory (Houghton et al. 1999, 2003)
 - !•!Tracer-transport inversion (Pacala et al. 2001)
- Estimates highly uncertain

BIOGEOCHEMICAL PERSPECTIVE

- How does woody plant encroachment affect carbon pools in ecosystems?
- Are there implications for greenhouse gas emissions (carbon credits, etc.)?
- If so, how might this change land management?

Can Ranchers Slow Climate Change?

Carbon credits can be created on rangelands at costs that are competitive with credits from cropland and forestry, revealing that ranchers could play a role in reducing climate change.

By

**S. Campbell, Siân Mooney, J.P. Hewlett, J. Menkhaus, and
G.F. Vance**

Rangelands 26:16-22 (2004)

Remote Sensing: How do ecosystem properties change with time over large areas?

+

Ecosystem Simulation Modeling: How do changes in ecosystem properties affect pools and fluxes of H₂O, C, N?

CENTURY
BIOM E-BGC

CASA
SPUR

TerraFlux
EPIC

GEM

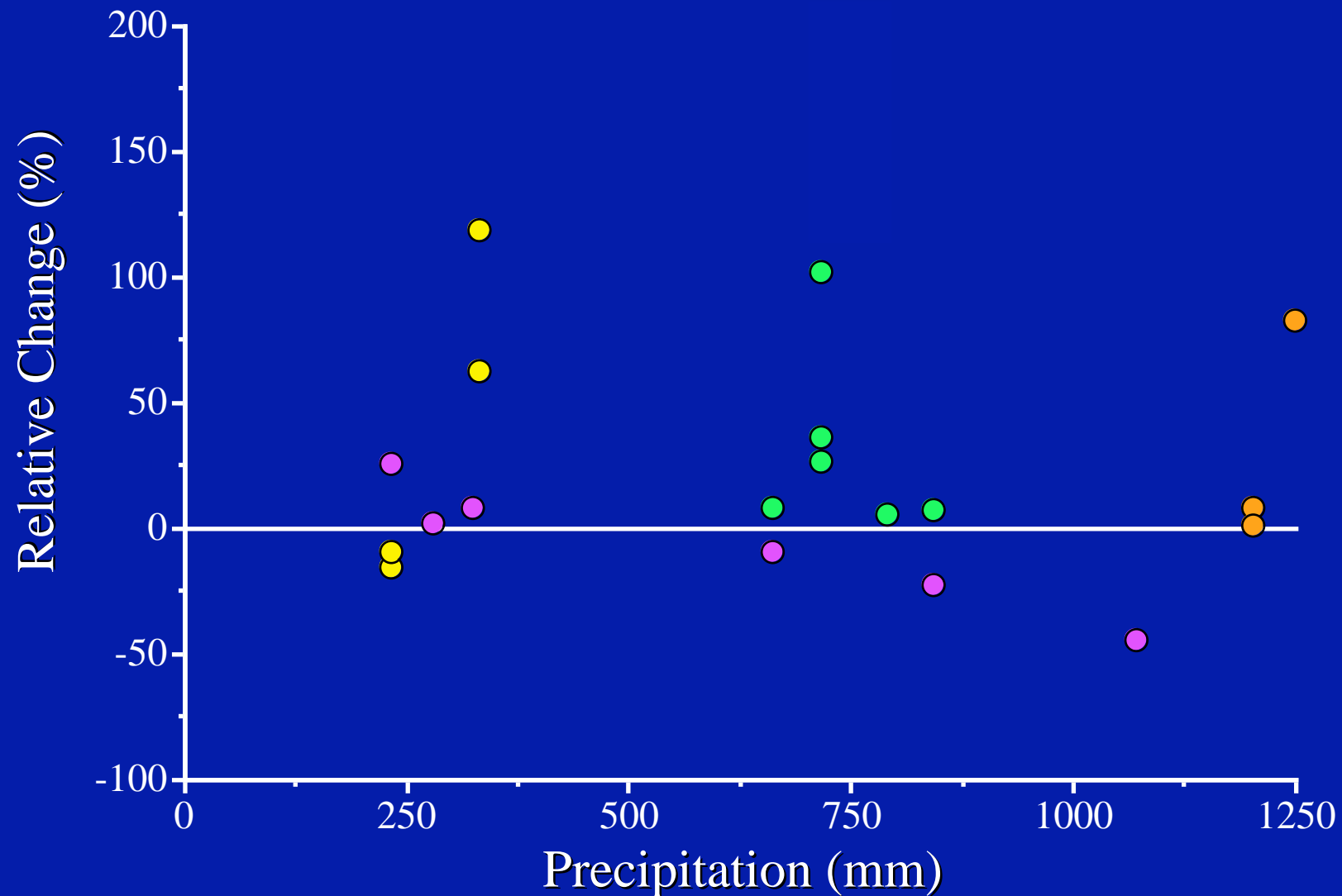
+

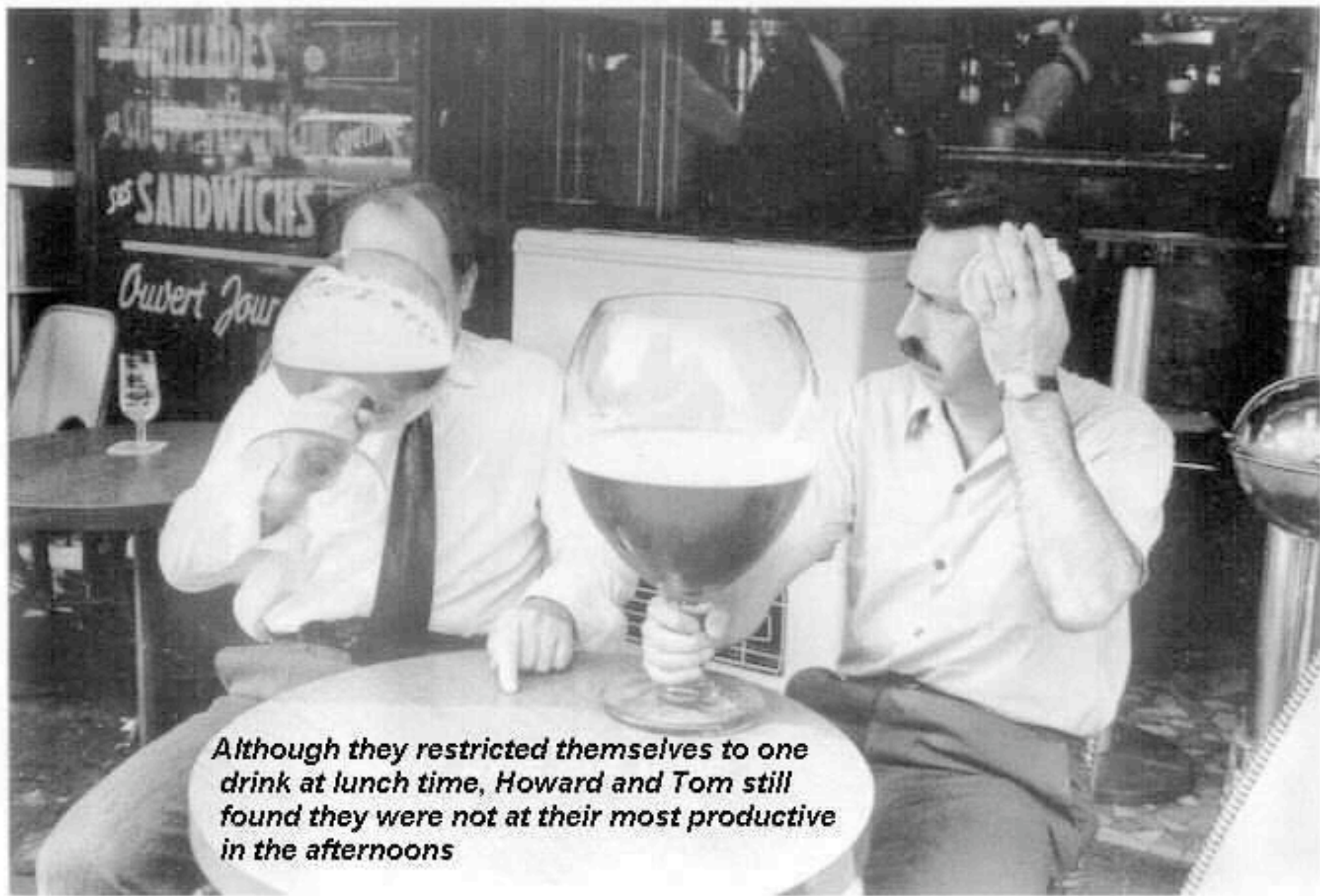
**Ground Truthing, Parameterization,
Performance Evaluation**

How do terrestrial C pools and fluxes change with changes in land cover?



Change in Soil Carbon with Woody Plant Proliferation





Although they restricted themselves to one drink at lunch time, Howard and Tom still found they were not at their most productive in the afternoons

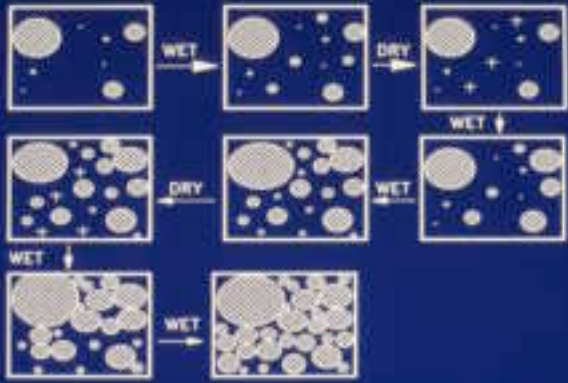
Why the variable influence of rainfall on SOC?

- Species Effects
- Temperature Effects
- Soil Texture Effects
- Land Use History Effects

All can be uniquely evaluated at SRER

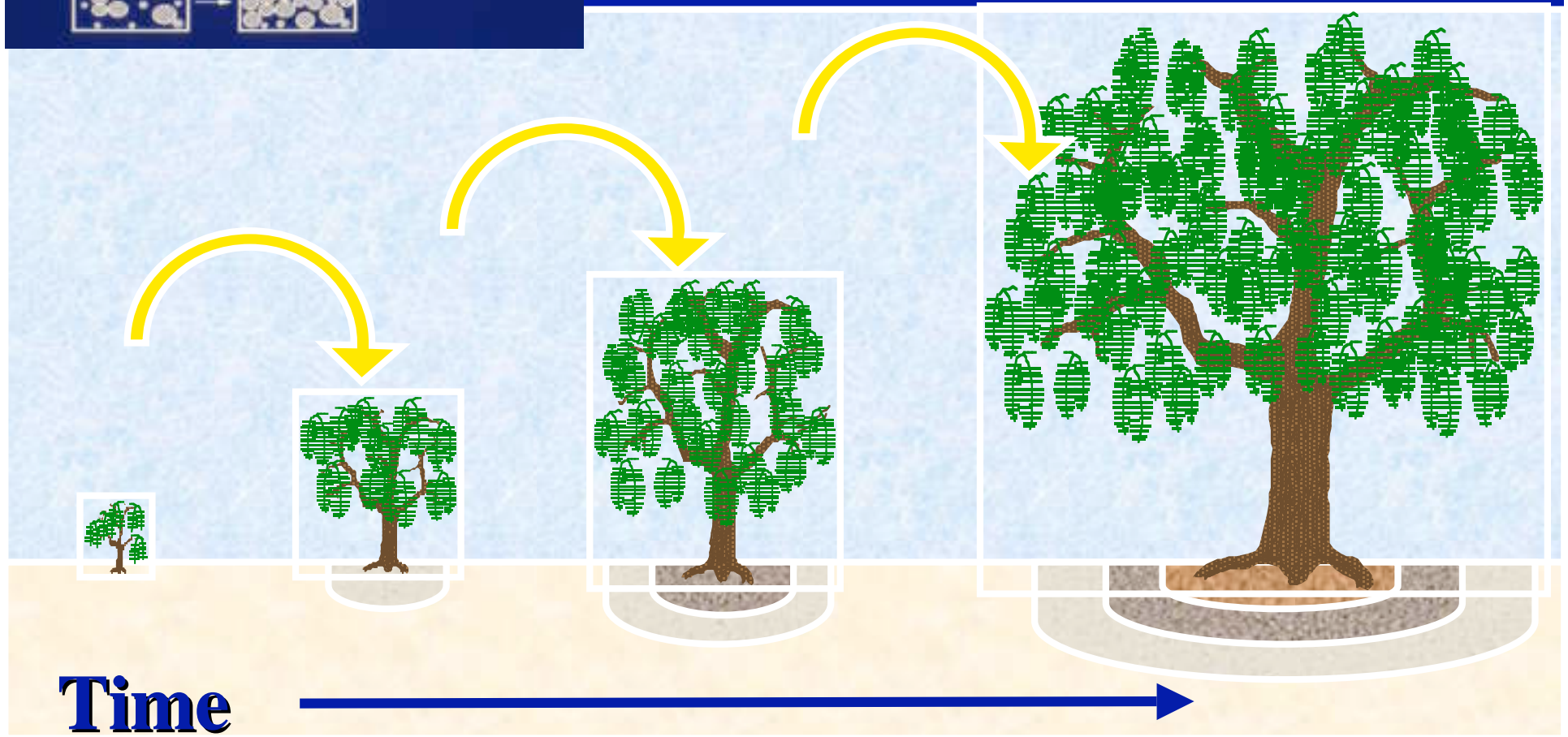
Woody plants modify soils subsequent to their establishment



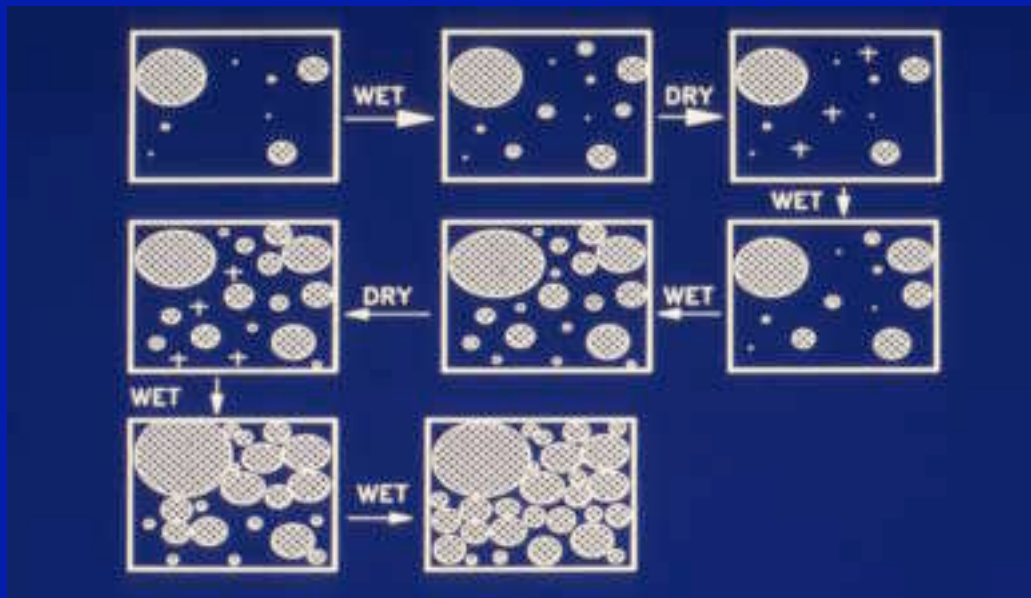


Accounting for tree size/age effects

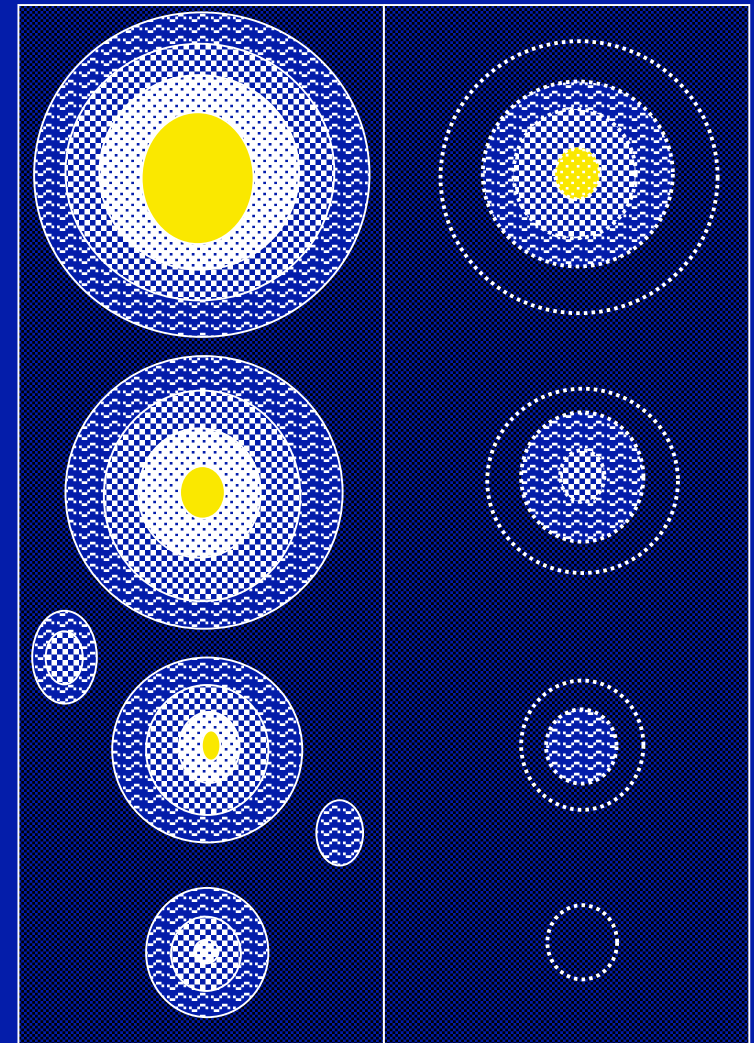
$SOC = f(\text{tree age, distance from bole})$



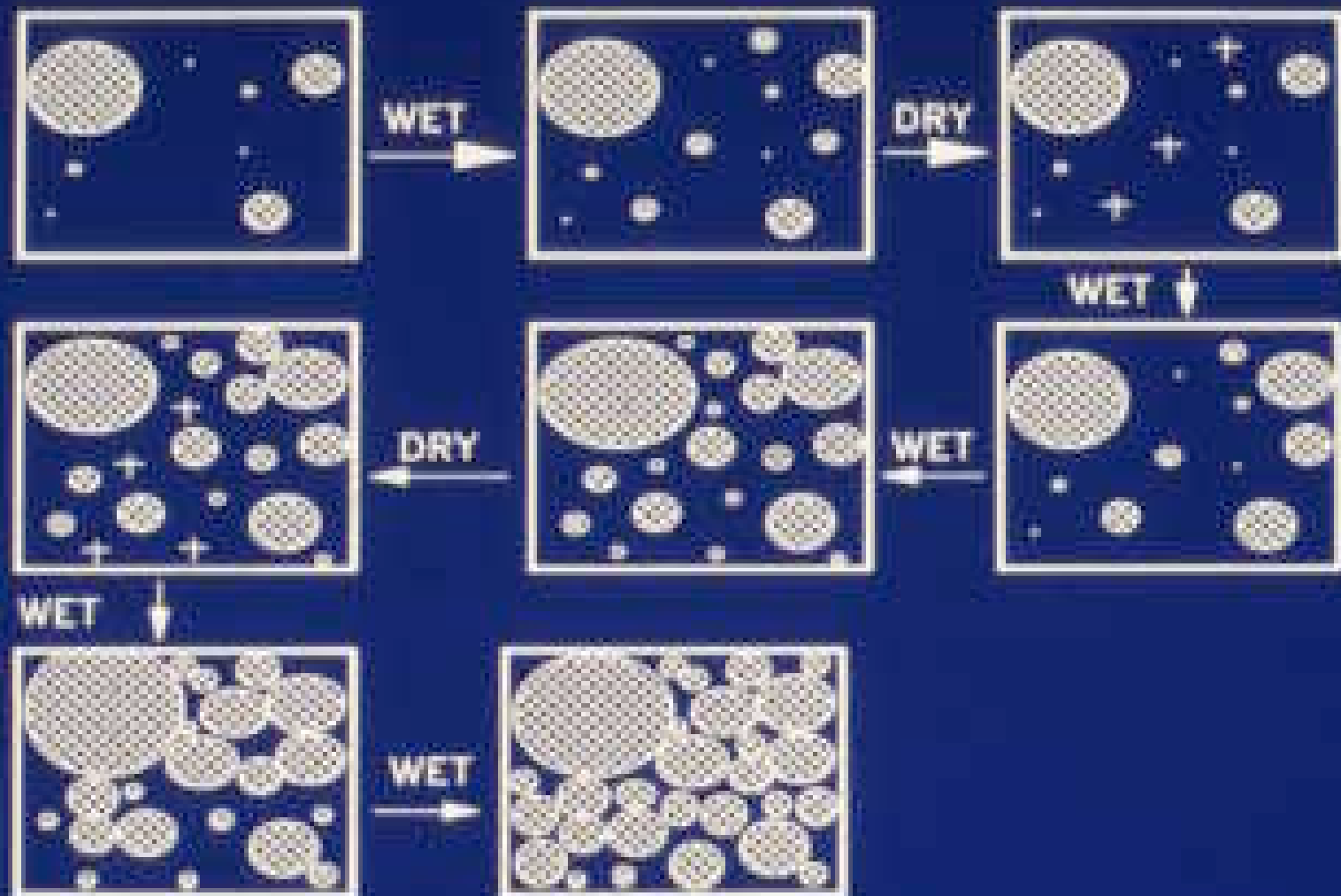
Area weighting algorithms to estimate SOC in tree age-states



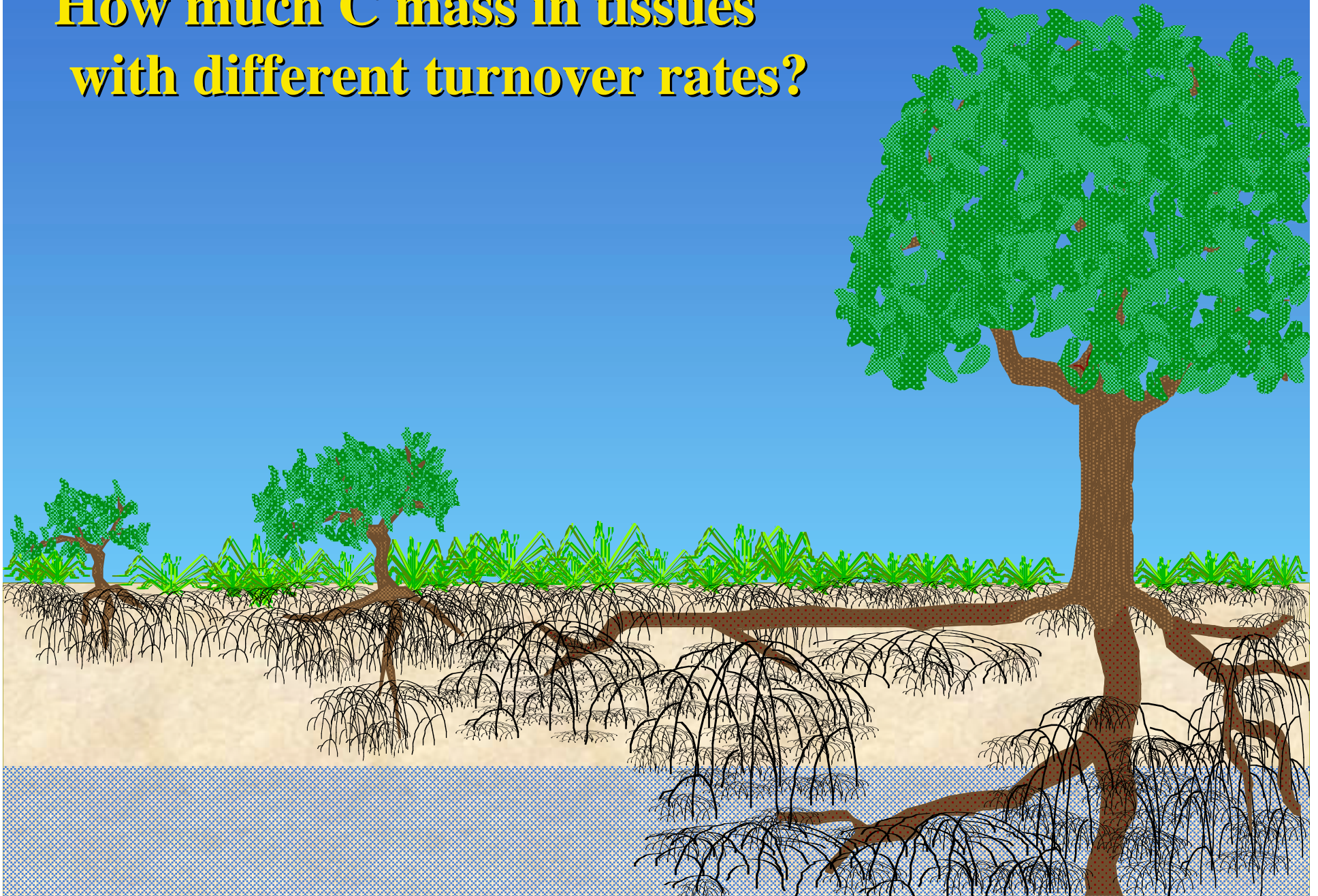
Control H-1960



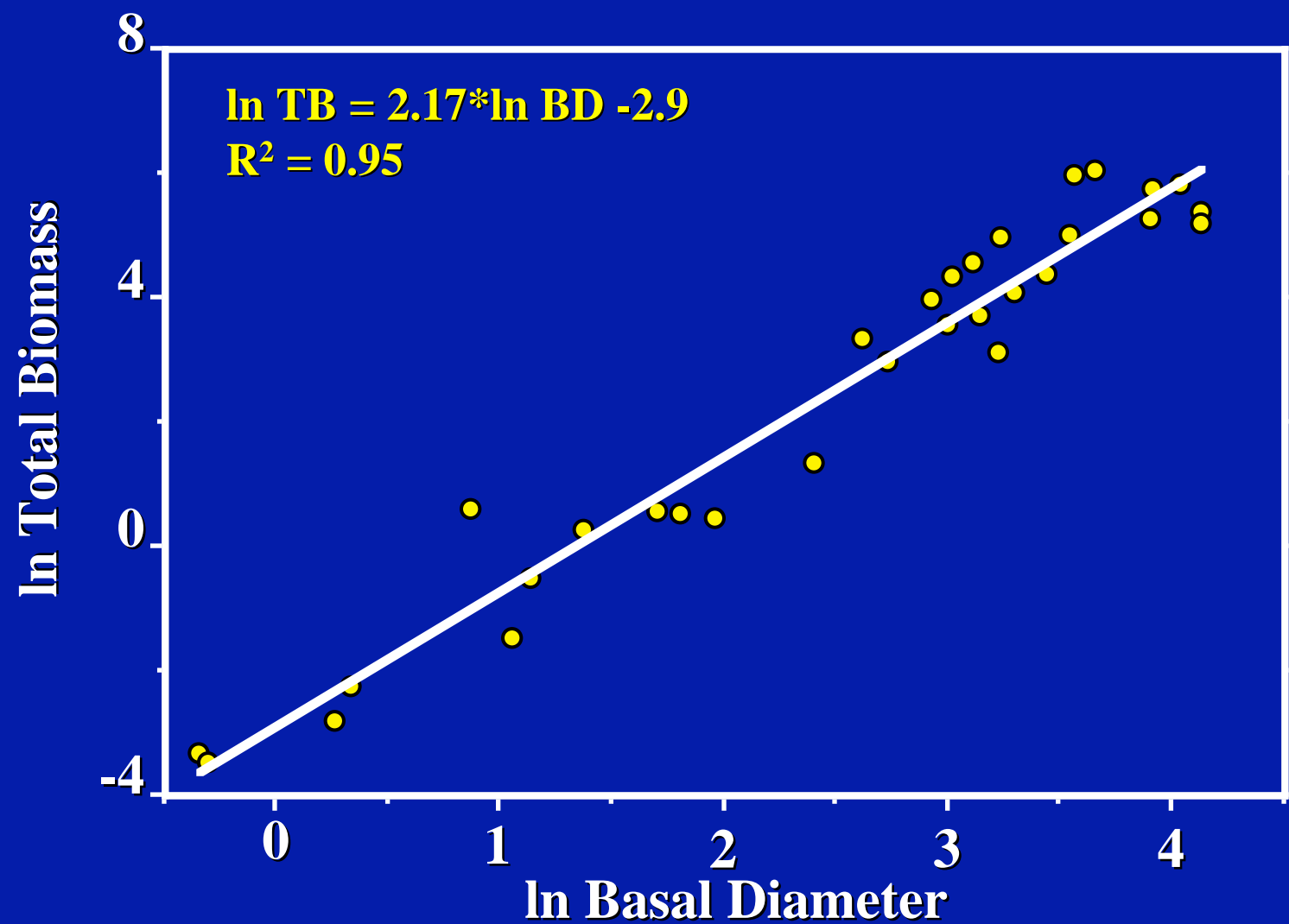
Changes in aboveground C pools with woody plant proliferation?



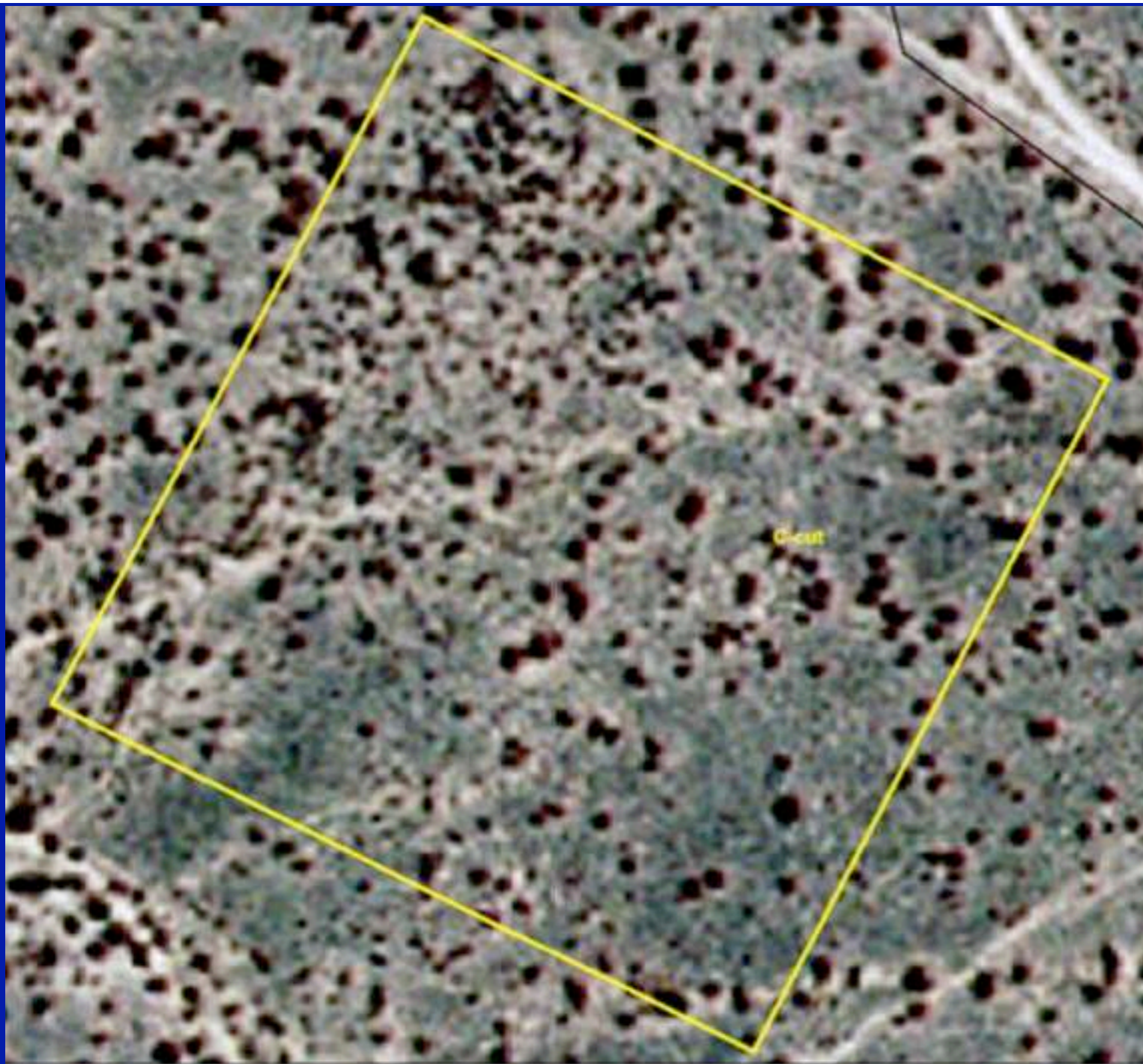
**How much C mass in tissues
with different turnover rates?**

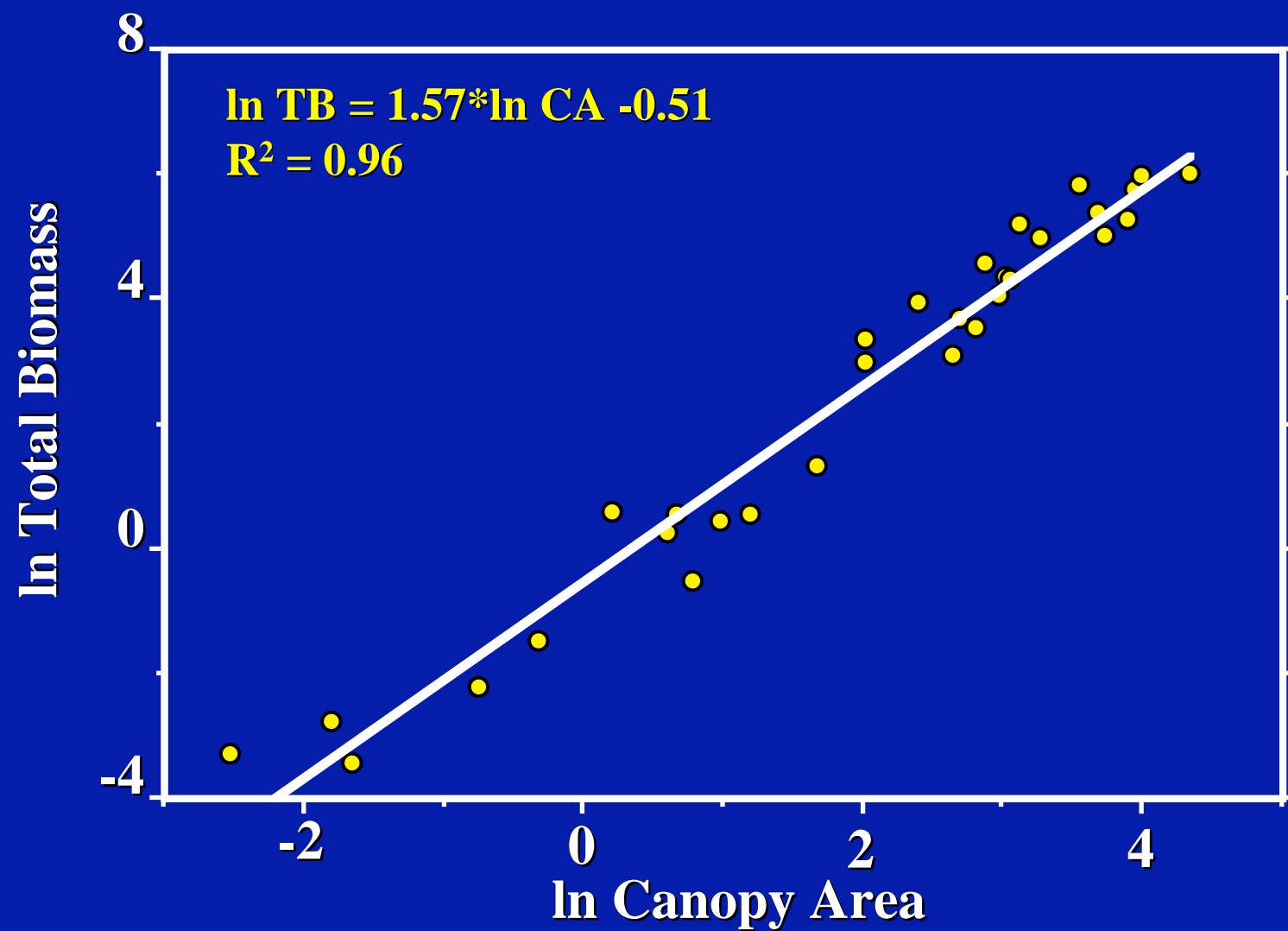




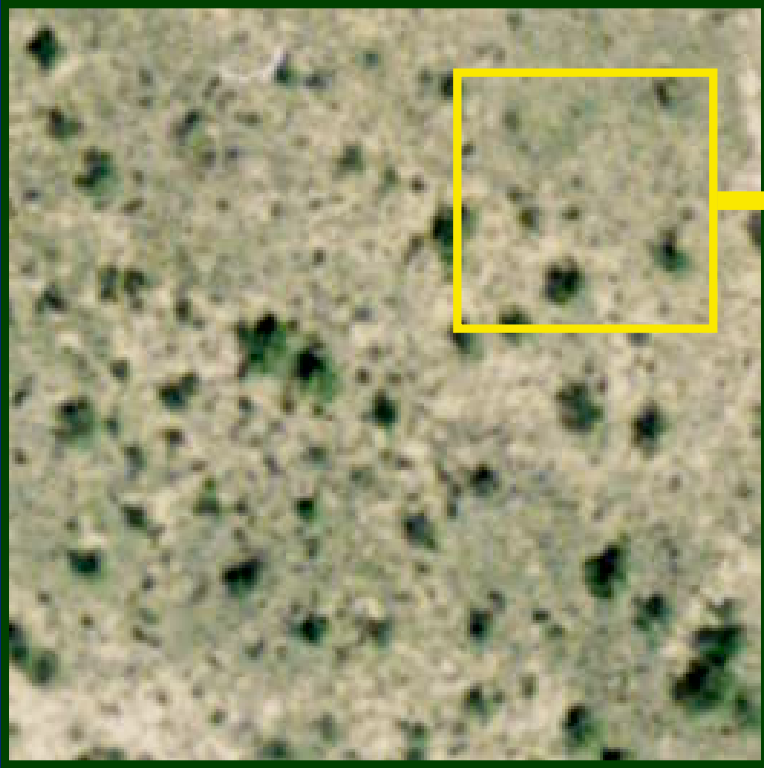






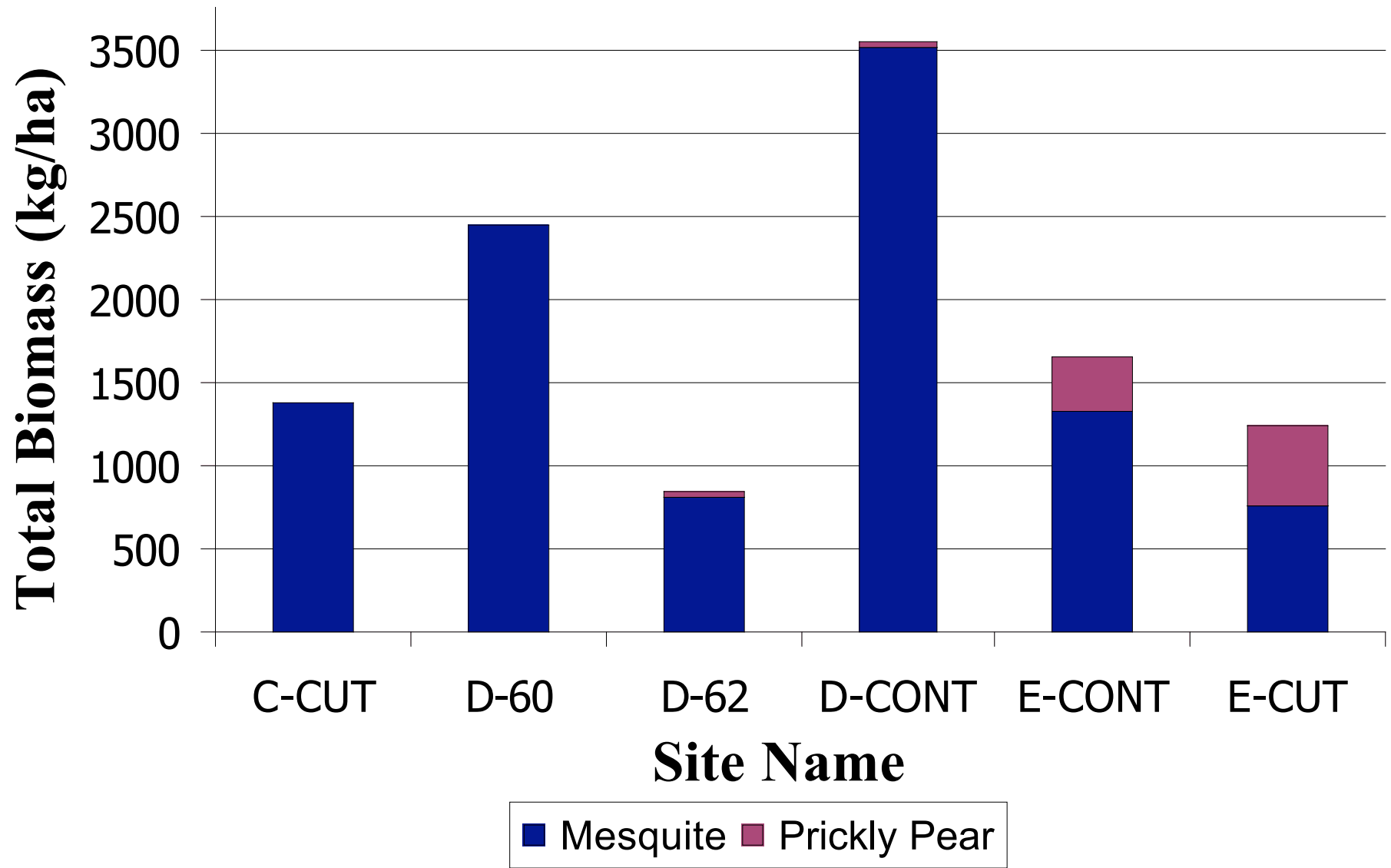






**How much carbon mass are we missing
by not accounting for *Opuntia*?**







1903



1941

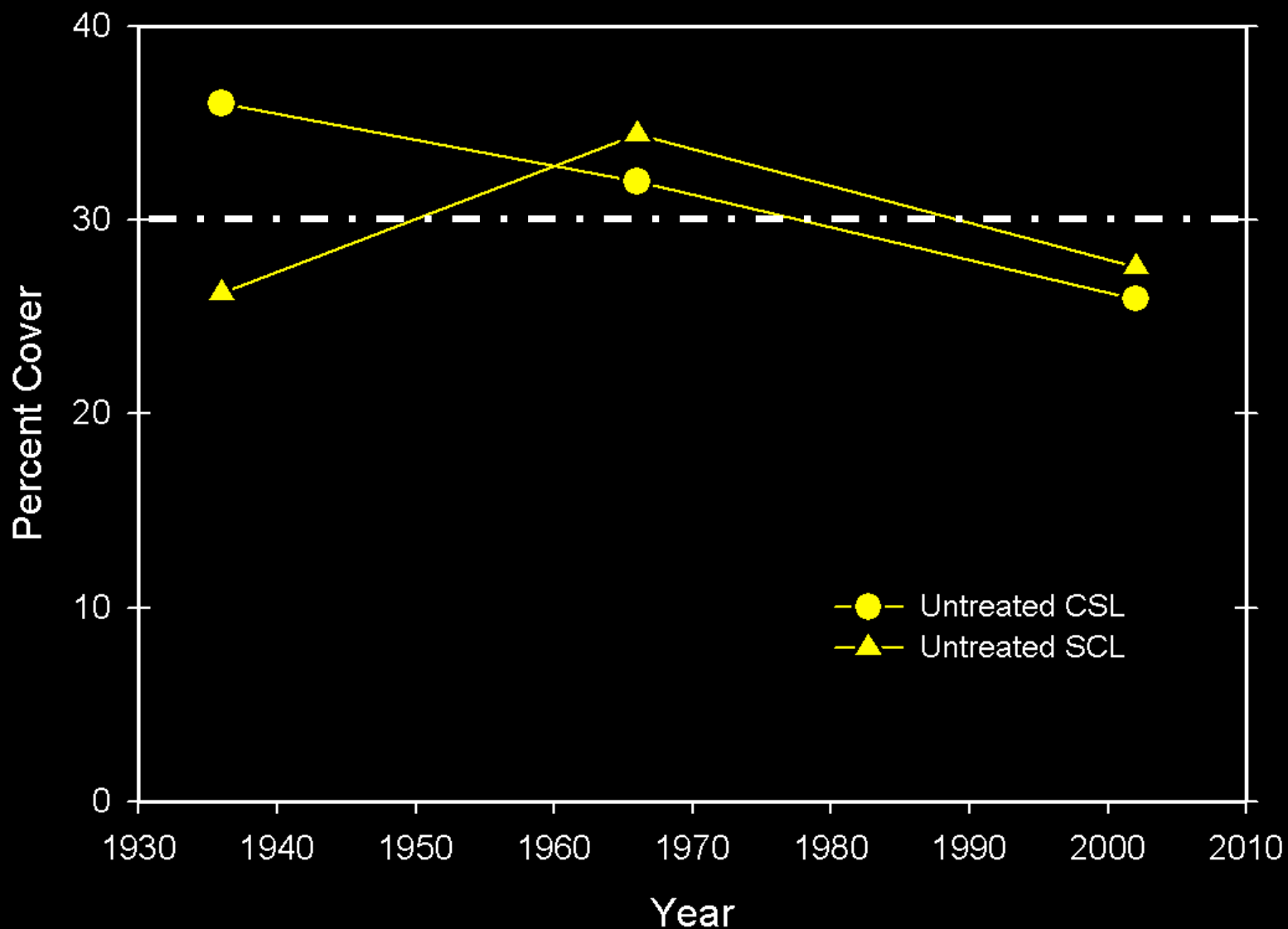
Early work

- Glendening, G. E. (1952): landscapes will stabilize at ~ 30% mesquite canopy cover.

Photo by Cribbs, 22 July 1935.

328798

Woody cover 1935-2002

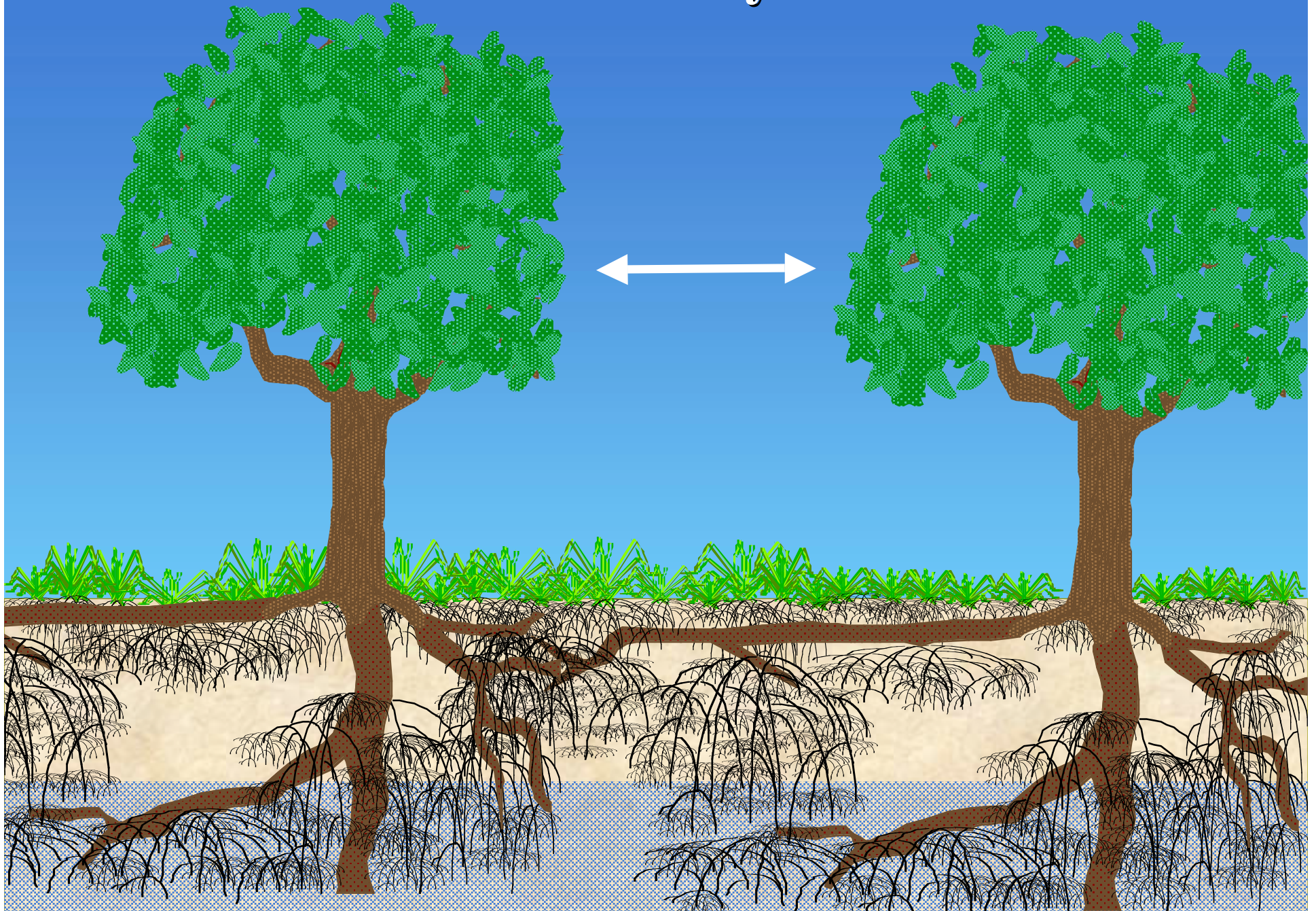


Projecting into the Future

After ca. 100 y of woody plant encroachment:

- Are we now approaching the climatic - edaphic “carrying capacity” for woody biomass?
- Are we transitioning from:
 - Recruitment and growth dynamics to maintenance and density-dependent mortality dynamics?
 - Directional change to dynamic fluctuation?

Tree on Tree: very few studies







No Pain....No Gain